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REPORT ON THE PUBLIC WATER SUPPLY OF DELAWARE, OHIO.

REPORT OF AN INVESTIGATION MADE BY THE ENGINEERING DIVISION OF THE OHIO
STATE DEPARTMENT OF HEALTH.

By F. H. WARING, Principal Assistant Engineer, Ohio State Department of Health.

INTRODUCTORY STATEMENT.

Under the law of Ohio providing for the correction of stream pollution and the improvement of impure and unsafe public water supplies,¹ upon complaint of a board of health of a city or village, or 10 per cent of the electors thereof, that the public water supply is impure and dangerous to health, the State commissioner of health is required to investigate the conditions complained of. If he finds the water supply to be impure and dangerous to health and that it is impracticable sufficiently to improve it by removing the source of pollution, or that the supply is being rendered impure by improper construction or inadequate size of water-purification works, he is required to notify such city, or the corporation owning or operating such water supply or water works, of his findings and of the time and place when and where a hearing may be had with the public health council.

If the public health council finds that the water supply is unsafe, the commissioner of health notifies the mayor or other officials, or officers of the corporation, to make the necessary changes to render it safe. If the findings or order of the commissioner of health are not acceptable to the city or corporation, referees are chosen to investigate, and they may affirm, reject, or modify the findings or order of the commissioner of health. An order as made by the commissioner of health or as approved or modified by the referees may be reversed, vacated, or modified by the supreme court if the court is of the opinion that such order was unlawful or unreasonable.

The article here presented is a report that was prepared to be presented at the hearing before the public health council of the State

¹ See page 1945.

department of health in regard to the safety of the public water supply and the necessity for the issuance of an order. It is believed that this report will be of especial interest and importance to water-works officials and health authorities, in view (1) of the finding of the failure of chlorination and (2) of the possible influence of hog cholera on the watershed above the intake upon the failure of chlorination and upon the epidemic of water-borne disease.

Acting upon a resolution of the Delaware District Board of Health, representatives of the State department of health made an investigation of the public water supply of Delaware, Ohio, on December 13, 1921. This water supply had been the subject of several investigations during the preceding three years; two had recently been made by the State department of health, one on November 17 and another on December 1, 1921.

The city of Delaware is centrally located in Delaware County, of which it is the county seat. The Olentangy River passes through the center of the city. The population according to the census of 1920 is 8,756. Delaware is a typical college community, and for the past 20 years the population has varied but little. Ohio Wesleyan University is located there, and the activities of the people in the city are closely associated with those of the college.

Municipal improvements comprise a very complete system of paved streets throughout the built-up sections; electric light and power, furnished by a private company; a public water supply system, owned and operated by the Delaware Water Co.; a fairly good sewerage system, designed and constructed on the separate plan and originally having a sewage treatment plant for disposal of the sanitary sewage. In recent years the treatment plant has been overtaxed, neglected, and practically abandoned.

SOURCE OF WATER SUPPLY.

The Delaware Water Co. was incorporated in 1888, and the water works were constructed and placed in operation the following year. The works are located three miles north of the city, on a tract of land bordering the Olentangy River. The original source of supply consisted of a dug well with a connecting infiltration gallery and an emergency intake at the end of the gallery extending into the Olentangy River. The soil formations in this vicinity consist of glacial deposits of about 25 feet in depth, overlying the bedrock of limestone. The sand and gravel just above the bedrock afford a limited supply of ground water.

As early as 1895 the records indicate the definite use of the emergency intake on account of the inadequate yield of the ground water

from the dug well and infiltration gallery. At this time typhoid fever was suspected as having been caused by the use of the river water. In 1896 the first attempt was made to procure a deep well supply and one well was drilled. In 1905 the public water supply was again suspected of being the cause of a typhoid fever epidemic, on account of the use of the river water through the emergency intake. Soon thereafter a standpipe was built on the distributing system to afford better storage of ground water; and in 1907, four additional deep wells were drilled. In 1908 and 1909, the water company began the practice of flooding the land adjacent to the well system and gallery and also added 13 tubular wells in the gravel deposits along the Olentangy River bank. Additional wells were installed in 1912, 1914, and 1920.

The existence of the emergency intake and the suspicion of unsatisfactory water supply led the water company to install chlorine disinfection devices in 1917. Since that date all water supplied to the city has been chlorinated in varying quantities and record kept of the amount of chlorine used and the amount of water treated. The use of Olentangy River for flooding land adjacent to the wells was made the subject of a report by the State department of health on October 11, 1917. Since that date, river water has been used directly through the emergency intake for a period of 15 days in January and February, 1918; at no time during 1919; and almost continuously from January 8, 1920, up to the time of this report, except for short periods when the quantity of ground water from the well system seemed to be adequate.

The Olentangy River watershed above Delaware has one city and 13 towns, with a total urban population of about 12,500. The drainage area above the waterworks intake is 383.8 square miles. The urban density of population for that portion of the area above the intake is about 33 per square mile. Seven of the communities are incorporated and only two have public water supply systems. The city of Galion has a population of 7,374 and the village of Mount Gilead a population of 1,837. Each of these communities has a sewerage system and a sewage treatment plant. Galion is 46 miles upstream, and Mount Gilead 25 miles upstream from the waterworks intake. There are 4 communities within 10 miles of the intake, the populations ranging from 116 to 344; but at no one of these is there a public water supply or sewerage system.

EXISTING WATERWORKS.

At the time of this investigation the Delaware waterworks consisted of the following: A source of supply comprising a system of drilled wells, a dug well and infiltration gallery, and an emergency intake into Olentangy River connecting into the infiltration gallery;

a pumping station adjacent to the well field and housing three high-service pumps; a 235,000-gallon standpipe located directly on the main to the city, at a point one-fourth mile from the pumping station; and several miles of distributing system mains serving practically the entire city.

The well system includes 25 drilled wells, 4 of which extend to a depth of over 225 feet, 1 is about 150 feet in depth, 1 is 92 feet in depth, and the remaining 19 are shallow tubular wells of about 25 feet in depth. All of the wells are cased down to the rock. The most recent well to be constructed was drilled in 1920 and is cased off at 150-foot depth. At the present time it supplies most of the water derived entirely from well sources.

The large dug well, infiltration gallery, and emergency river intake represent the original water supply development and still remain in use. The dug well is 30 feet in diameter by 28 feet deep, is finished with stone walls without mortar joints, and has a concrete slab top covered with earth. Connecting to the dug well is an infiltration gallery 4 feet high by 6 feet wide, also constructed of loose stone and having a stone slab cover. The gallery is 293 feet long. It is parallel with and approximately 100 feet from the bank of the river. These two structures are built in excavation for about 3 feet into the bedrock.

Located almost immediately over the infiltration gallery and some of the wells there were formerly five land filters. These so-called natural filters were constructed by stripping the soil to make embankments in order to subdivide the area into filtering units. In an attempt to force the yield of the wells still further, there was constructed in 1920 a vertical filter wall 26 feet in width, consisting of fine sand and located between the dug well and the land filters. Both of these schemes were definitely abandoned in the fall of 1920.

The pumping equipment consists of two high-duty Deane duplex pumps and one high-duty Knowlson and Kelly pump. The suction connections and valve arrangements are such that water may be pumped from the dug well and gallery alone or from the drilled well system alone or from the two together. At the present time water is being taken from the Olentangy River through the emergency intake, infiltration gallery, and dug well almost continuously. It is the practice to operate the pumps according to a certain predetermined maximum vacuum, and if the ground water available from the drilled well system is not adequate to make easy pumping, water is drawn from the partially open valve from the dug well, infiltration gallery, and river intake systems.

Disinfection equipment is installed in the pump station in a special partitioned space in the engine room. This equipment consists of a Wallace & Tiernan chlorinator of the M. S. B. manually controlled

type, capable of applying quantities of chlorine varying from 5 pounds per day up to any desired amount. To assist in the accurate treatment of the water pumped, a Venturi meter has been installed upon the main discharge line from the plant. Suitable indicating and recording devices register the amount of water being pumped and the chlorine being applied.

QUALITY OF WATER SUPPLY.

The public water supply of Delaware was first chlorinated on May 3, 1917. Since that time continuous chlorination of all water pumped has taken place. Regular reports of operation are submitted to the State department of health, showing the performance of the chlorination plant. The information submitted includes data upon the analyses of the treated water as shown by weekly samples analyzed by the consulting analyst for the water company.

In November 1920, the Delaware Water Co. replaced the original chlorinator with a new and larger type of installation (the description of which is given above). The change was made necessary on account of the limitation in maximum quantity of chlorine that could be applied by the old machine. The consulting analyst had reported occasional poor results, and the limited capacity of the machine was blamed for the inefficient disinfection of the water supply.

Analytical studies of the disinfection of the public water supply made by the State department of health were begun February 19, 1918, just after river water had been used through the direct intake. The results of these studies showed unsatisfactory disinfection of the water. On March 18, 1918, the survey made by the State department of health showed the water to be of satisfactory sanitary quality. No use of river water had been made during the interval. During 1919, river water was not used, and no sampling of the water by this department was undertaken. Reports of the consulting analyst for the Delaware Water Co. indicated satisfactory water during that year. In 1920, samples were collected by representatives of the department on four different occasions, and each time the study represented river water in combination with certain amount of well water, the combined waters being treated by the disinfection process. The results were uniformly poor, showing the disinfection to be not entirely satisfactory.

In 1921, samples were collected on two different occasions, only one of which was following the use of the Olentangy River water. The results of samples collected, particularly on November 28, indicate that the water was not entirely satisfactory from a sanitary standpoint, in spite of continuous excessive chlorination, varying between one and two parts per million. Presence of turbidity was noted in all of the

tap samples collected November 28, on account of the flood conditions of Olentangy River. On December 13 the river was not being used as a source of supply, and, accordingly, the results of analyses of samples collected on that date indicate fairly satisfactory disinfection of the water supply.

The citizens of Delaware complained regarding the tastes resulting from excessive chlorination throughout the year 1921, and it is, therefore, evident that the company had been making the attempt to disinfect the water in a manner to make it safe. There have been no interruptions in the chlorine treatment; but, nevertheless, numerous tests made by the consulting analyst have showed unsatisfactory results in the Delaware tap water during 1921. The tests made by the State department of health on November 28 check the poor results obtained by the consulting analyst. It is apparent, therefore, that disinfection of the combined river water and well water has failed.

OUTBREAK OF ENTERITIS.

During October and November, 1921, an extensive outbreak of intestinal disease occurred in the city of Delaware. This disturbance was particularly pronounced about the middle of November. The division of communicable diseases made investigation of approximately 743 cases of suspected illness and reported 373 of these definitely to be enteritis. The conclusion as to the responsibility for the epidemic was that the public water supply was to blame. This conclusion was reached after a careful epidemiological study of the cases both positive and suspected.

Coincident with the outbreak of enteritis came the steady rains of the autumn season of the year, resulting in turbid water of probably highly polluted character flowing in the Olentangy River. During this interval, river water was being used as a source of supply variously estimated at from 25 per cent to 75 per cent of the whole supply pumped at the water works. Samples of the city tap water taken November 28 indicated conclusively that chlorine disinfection of the water had failed.

An inspection of watershed conditions above the Delaware water works intake on December 13 revealed the fact that three farms within 7 miles of the intake had experienced an epidemic of hog cholera, resulting in the death of about 40 animals between October 1 and December 13. It developed that proper disposition had not been made of some of these animals, and it certainly seemed probable that the character of run-off in the river was seriously affected by the bacterial pollution resulting from the cholera epidemic among the hogs.

TYPHOID FEVER DATA.

The city of Delaware has experienced rather frequent occurrences of typhoid fever during the past two decades. The public water supply has been suspected as being the cause of most of the instances. Previous to the installation of the chlorine disinfection devices in May, 1917, the average typhoid death rate for 9 years was 32.1 per hundred thousand. For the four years following the installation of the water disinfection devices, the typhoid death rate has averaged 11.3 per hundred thousand. A similar reduction in the case rate is indicated.

It is pertinent to note that all of the cases of typhoid fever that occurred in Delaware in 1921 occurred in the period between September 1 and December 3, coincident with the enteritis outbreak which has been definitely attributed to the public water supply. The typhoid cases have been relatively mild, and no deaths occurred in 1921.

RECENT EFFORTS TOWARD IMPROVING THE PUBLIC WATER SUPPLY.

As noted previously in this report, the Delaware Water Co. has made several attempts to furnish a public water supply adequate enough in yield from the wells to permit abandonment of the emergency river connection. All attempts to increase the ground water supply satisfactorily have failed. On October 11, 1917, the State health department approved a scheme of supplementing the ground water supply by the use of land filters, but made approval conditional on the abandonment of the river intake and satisfactory operation of the chlorine disinfection devices.

The Delaware Water Co. became convinced that it was not possible to comply with the two conditions mentioned, and, accordingly, on March 18 and May 25, 1920, preliminary plans were filed with the State department of health for a modern rapid sand filter plant to be built at the site of the existing works and using Olentangy River as a source of supply. Subsequently the city of Delaware considered the proposition to provide a municipal water supply and, accordingly, did not give the water company renewal of contract for water rental at the proposed schedule of rates filed. The city and the company each had appraisals of the water works made; but the city did not agree to purchase the works, nor did it signify its attitude with respect to a purchase.

The company has been unsuccessful in getting a contract for water rates that would permit the construction of a filter plant and has appealed to the public utilities commission for an adjustment of water rates to give a fair return on the existing works. In all probability the company will seek an added rate adjustment to permit the financing of a new water purification plant. At the time of this

report, this rate question is before the public utilities commission for decision. In the meanwhile the water company has employed a consulting engineer to prepare complete plans for a water purification and softening plant. The company has expressed in writing to the State department of health its intention of constructing the water purification plant devices if favorable rate adjustments can be obtained.

SUMMARY.

Acting upon the petition adopted by the Delaware District Board of Health December 8, 1921, in accordance with the provisions of section 1252 of the General Code of Ohio, the public water supply of Delaware was investigated by representatives of the State department of health. It was found that the existing sources of supply consisted of ground water supplemented by use of Olentangy River water, the use of the latter having been almost a regular procedure during 1920 and 1921. The disinfection treatment of the water supply during this interval was not sufficiently uniformly satisfactory to make the water suitable from a sanitary standpoint. The conclusion reached, therefore, is that the public water supply has been found to be impure and dangerous to health and that it is not practicable to sufficiently improve the character of the supply by removing the sources of pollution affecting it. The complaint of the city board of health is justified, and action should be taken by the State department of health to compel the installation of the necessary public water supply improvements.

Appendix.

TABLE I.—*Municipalities on Olentangy River watershed above Delaware waterworks intake.*

Area of watershed above Delaware waterworks intake.....sq. miles.. 384
Total urban population..... 12,550
Urban population per sq. mile..... 33

Distance above intake.	City or town.	Popula- tion.	Incorporated.	Remarks.
<i>Miles.</i>				
7.....	Norton.....	116	No.....	West Branch; no water supply; no sewers.
9.....	Waldo.....	344	Yes.....	Do.
9.....	Westfield.....	118	No.....	East Branch; no water supply; no sewers.
10.....	Ashley.....	¹ 260	Yes.....	Do.
17.....	Cardington.....	1,109	Yes.....	Do.
23.....	Edison.....	386	Yes.....	Do.
25.....	Mt. Gilead.....	1,837	Yes.....	East Branch; water supply; sewage treatment.
27.....	Caledonia.....	492	Yes.....	West Branch; no water supply; no sewers.
31.....	(Martel.....	151	No.....	Do.
	(Climax.....	62	No.....	Do.
	(Iberia.....	150	No.....	Do.
35.....	New Winchester.....	107	No.....	Do.
	(St. James.....	44	No.....	Do.
46.....	Galion.....	7,374	Yes.....	West Branch; water supply; sewage treatment.
Total..	14.....	12,550	7 incorporated; 7 unincorporated.	2 water supply, sewage treatment; 12 no water supply, no sewers.

¹ Population of Ashley is 786. About one-third of the village is on the Olentangy River watershed.

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The following summary of investigations of outbreak of enteritis at Delaware, Ohio, in 1921, were compiled from records of the division of communicable diseases, Ohio State Department of Health.

TABLE II.—*Chronology of enteritis cases.*

Date of onset.	Number of positive cases.	Date of onset.	Number of positive cases.
1921.		1921.	
October 1 to 10.....	40	November 11 to 20.....	240
October 11 to 20.....	0	November 21 to 30.....	12
October 21 to 31.....	1		
November 1 to 10.....	80	Total.....	373

TABLE III.—*Relation of water supply to occurrence of enteritis.*

Water supply used.	Suspected and positive cases.		Positive cases.	
	Number.	Per cent.	Number.	Per cent.
City water exclusively.....	643	86.5	364	97.6
Well water exclusively.....	56	7.6	2	0.5
Both city and well water.....	44	5.9	7	1.9
Total.....	743	100	373	100

NOTE.—Total number of positive enteritis cases equals 59.2 per cent of total suspected and positive cases.

TABLE IV.—*Typhoid fever at Delaware, Ohio.*¹

Year.	Population.	Total cases.	Total deaths.	Case rate (per 100,000).	Death rate (per 100,000).
1909.....	8,995	.....	5	.....	55.6
1910.....	9,076	.....	6	.....	66.1
1911.....	9,044	.....	1	.....	10.5
1912.....	9,012	.....	1	.....	11.0
1913.....	8,980	4	2	44.5	22.2
1914.....	8,948	4	2	44.7	22.3
1915.....	8,916	.....	1	.....	11.2
1916.....	8,884	32	3	360.0	33.7
1917.....	8,852	10	5	113.0	56.5
1918.....	8,820	4	2	² 45.4	² 22.7
1919.....	8,788	6	1	68.3	11.4
1920.....	8,756	9	1	102.8	11.4
1921.....	8,800	10	0	³ 113.6	³ 0.0
Average.....				(8 yrs.) 111.5	(13 yrs.) ⁴ 25.7

¹ From Ohio State Department of Health mortality records 1909-1921.

² Chlorination of public water supply begun May 3, 1917.

³ Typhoid records for 1921 up to December 15, 1921; all cases occurred during period September 1 to December 3.

⁴ Average typhoid death rate for 9 years before chlorination, 32.1; for 4 years after chlorination, 11.4.

TABLE V.—Summary of analyses of public water supply at Delaware.
[Ohio State Department of Health Laboratories.]

Date of survey.	Water treatment data.				Bacteriological data.								
	River intake used.	Appearance of water treated.	P.P. M. chlorine applied.	P.P. M. residual chlorine.	No. of city tap samples.	Bacteria per c.c.		B. coli results (confirmed).					
						Average at 20°C.	Average at 37°C.	1 c. c.			10 c. c.		
								Neg.	Sus.	Pos.	Neg.	Sus.	Pos.
Feb. 9, 1918....	Yes....	Turbid..	0.45	.....	6	291	42	6	0	0	1	2	3
Mar. 18, 1918....	No....	Clear....	0.20	.....	7	77	51	6	0	0	6	0	0
Jan. 9, 1920....	Yes....	Clear....	0.35	.....	4	26	33	0	4	0	0	3	1
Nov. 13, 1920....	Yes....	Clear....	1.00	.....	6	103	50	6	0	0	6	0	0
Dec. 2, 1920....	Yes....	Turbid..	1.80	0.35	12	84	154	12	0	0	6	4	2
Dec. 20, 1920....	Yes....	Turbid..	1.80	0.35	12	41	15	5	2	5	3	4	5
Nov. 17, 1921....	Yes....	Turbid..	1.70	0.25	8	114	130	8	0	0	2	6	0
Dec. 13, 1921....	No....	Clear....	1.30	.....	10	4	2	10	0	0	10	0	0

Report of operation of the Delaware Water Co. disinfection plant to the Ohio State Department of Health.

AUGUST, 1921.

Date.	Total water treated (thousands of gallons).	Pounds.		Temperature of water.	Parts per million.			Bacterial results.							
		Hypo.	Liq. Cl.		Turbidity.	Color.	Iron.	20° C—48 Hrs.		37° C—24 Hrs.		Presumptive B. Coli.			
								Raw.	Disinf.	Raw.	Disinf.	Bile—Broth.			
												Raw.		Disinf.	
												1 c.c.	10 c.c.	1 c.c.	10 c.c.
1.....	1,197	14	° F.												
2.....	1,144	14													
3.....	1,014	15													
4.....	1,074	13											0	0	
5.....	1,005	14													
6.....	990	13½													
7.....	970	12													
8.....	1,113	14													
9.....	1,143	14													
10.....	1,070	13													
11.....	1,003	13													
12.....	1,032	14½													
13.....	1,085	13½											0	0	
14.....	935	13													
15.....	1,080	13½													
16.....	937	13½													
17.....	1,160	14													
18.....	998	13½											0	0	
19.....	981	12													
20.....	1,031	13½													
21.....	970	14													
22.....	1,005	14½													
23.....	1,090	14													
24.....	1,075	13													
25.....	1,104	15											0	0	
26.....	1,072	14½													
27.....	1,017	15													
28.....	1,139	14													
29.....	1,303	17													
30.....	1,237	15½													
31.....	1,190	14½													
Total.....	33,075	1476½										204		0/4	0/4
Average.....	1,066											51			
Maximum.....	1,237											150			
Minimum.....	937											9			

1 1.72 p. p. m.

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Report of operation of the Delaware Water Co. disinfection plant to the Ohio State Department of Health—Continued.

SEPTEMBER, 1921.

Date.	Total water treated (thousands of gallons).	Pounds.		Temperature of water.	Parts per million.			Bacterial results.							
		Hypo.	Liq. Cl.		Turbidity.	Color.	Iron.	20° C— 48 Hrs.		37° C— 24 Hrs.		Presumptive B. Coli.			
								Raw.	Disinf.	Raw.	Disinf.	Bile—Broth.			
												Raw.		Disinf.	
												1 c.c.	10 c.c.	1 c.c.	10 c.c.
1.....	1,114	15	° F.												
2.....	1,020	14													
3.....	947	13								(1)					
4.....	906	14													
5.....	991	14													
6.....	1,010	15													
7.....	1,068	15													
8.....	1,035	15													
9.....	1,058	15									30			0	0
10.....	986	14													
11.....	804	14													
12.....	1,058	14½													
13.....	1,178	14½													
14.....	1,034	15													
15.....	1,064	13½													
16.....	1,110	15													
17.....	943	14									90			0	(2)
18.....	857	13													
19.....	1,067	15													
20.....	1,215	14													
21.....	1,018	14½													
22.....	1,097	12													
23.....	1,072	14									2,000			0	0
24.....	1,088	15													
25.....	1,010	14½													
26.....	1,095	14½													
27.....	1,068	14½													
28.....	1,221	14½													
29.....	1,139	15												0	0
30.....	1,388	15									20				
Total.....	31,791	430									2,140			0/4	1/3
Average.....	1,059	14.3									535				
Maximum.....	1,388	15									2,000				
Minimum.....	857	12									20				

OCTOBER, 1921.

1.....	1,100	16													
2.....	923	13													
3.....	797	15													
4.....	967	14													
5.....	1,068	15													
6.....	1,142	14½													
7.....	1,010	14									50			0	0
8.....	964	15													
9.....	775	12½													
10.....	865	13													
11.....	1,094	13													
12.....	1,147	15													
13.....	1,231	12½									8			0	0
14.....	1,345	15													
15.....	826	15													
16.....	827	13													
17.....	1,148	15													
18.....	844	14													
19.....	852	13½													
20.....	802	14									18			0	0

¹ Broken in transit.² Positive.³ 1.63 p. p. m.

August 11, 1922.

1944

Report of operation of the Delaware Water Co. disinfection plant to the Ohio State Department of Health—Continued.

OCTOBER, 1921—Continued.

Date.	Total water treated (thousands of gallons).	Pounds.		Temperature of water.	Parts per million.		Bacterial results.								
		Hypo.	Liq. Cl.		Turbidity.	Color.	Iron.	20° C— 48 Hrs.		37° C— 24 Hrs.		Presumptive B. Coli.			
								Raw.	Disinf.	Raw.	Disinf.	Bile—Broth.			
												Raw.		Disinf.	
												1 c. c.	10 c. c.	1 c. c.	10 c. c.
21.....	1,001	.....	19½	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
22.....	901	.....	11½	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
23.....	1,069	.....	13½	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
24.....	1,120	.....	13	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
25.....	1,055	.....	12	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
26.....	1,150	.....	14	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
27.....	1,129	.....	12	.....	.....	.....	.....	.....	.....	6	.....	.....	0	0	.....
28.....	1,165	.....	15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
29.....	1,054	.....	12	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
30.....	1,012	.....	13	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
31.....	1,016	.....	14	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total.....	31,366	.....	143½	.....	.....	.....	.....	.....	.....	82	.....	.....	0/4	0/4	.....
Average.....	1,011	.....	.....	.....	.....	.....	.....	.....	.....	20	.....	.....	.....	.....	.....
Maximum.....	1,345	.....	.....	.....	.....	.....	.....	.....	.....	50	.....	.....	.....	.....	.....
Minimum.....	775	.....	.....	.....	.....	.....	.....	.....	.....	6	.....	.....	.....	.....	.....

NOVEMBER, 1921.

1.....	978	.....	14	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2.....	958	.....	15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
3.....	957	.....	12	.....	.....	.....	.....	.....	.....	40	.....	.....	.....	0	(2)
4.....	980	.....	16	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
5.....	953	.....	16	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
6.....	1,015	.....	17	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
7.....	1,025	.....	13	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
8.....	1,036	.....	14½	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
9.....	1,046	.....	13½	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
10.....	1,147	.....	13½	.....	.....	.....	.....	.....	.....	40	.....	.....	.....	0	0
11.....	1,079	.....	13	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
12.....	945	.....	15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
13.....	1,053	.....	13	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
14.....	950	.....	14	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
15.....	1,094	.....	12	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
16.....	1,046	.....	13	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
17.....	1,167	.....	11	.....	.....	.....	.....	.....	.....	50	.....	.....	.....	0	(2)
18.....	1,035	.....	14	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
19.....	915	.....	15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
20.....	1,042	.....	15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
21.....	1,008	.....	15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
22.....	1,015	.....	13	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
23.....	997	.....	14	.....	.....	.....	.....	.....	.....	0	.....	.....	.....	0	0
24.....	868	.....	13½	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
25.....	770	.....	14	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
26.....	951	.....	12½	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
27.....	954	.....	14	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
28.....	1,083	.....	14½	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
29.....	1,035	.....	15	.....	.....	.....	.....	.....	.....	4	.....	.....	.....	0	0
30.....	993	.....	13	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total.....	30,105	.....	548	.....	.....	.....	.....	.....	.....	134	.....	.....	.....	0/5	2/3
Average.....	1,003	.....	.....	.....	.....	.....	.....	.....	.....	27	.....	.....	.....	.....	.....
Maximum.....	1,167	.....	.....	.....	.....	.....	.....	.....	.....	50	.....	.....	.....	.....	.....
Minimum.....	770	.....	.....	.....	.....	.....	.....	.....	.....	0	.....	.....	.....	.....	.....

¹ 1.65 p. p. m.² Positive.³ 1.13 p. p. m. (min.).⁴ 1.96 p. p. m. (max.)⁵ 1.66 p. p. m.

1945

August 11, 1922.

Report of operation of the Delaware Water Co. disinfection plant to the Ohio State Department of Health—Continued.

DECEMBER, 1921.

Date.	Total water treated (thousands of gallons).	Pounds.		Temperature of water.	Parts per million.			Bacterial results.								
		Hypo.	Liq. Cl.		Turbidity.	Color.	Iron.	20° C— 48 Hrs.		37° C— 24 Hrs.		Presumptive B. Coli.				
								Raw.	Disinf.	Raw.	Disinf.	Bile—Broth.				
												Raw.		Disinf.		
												1 c. c.	10 c. c.	1 c. c.	10 c. c.	
1.....	777	12	° F.													
2.....	878	14½														
3.....	976	15														
4.....	535	15														
5.....	1,013	14½														
6.....	879	15														
7.....	934	15														
8.....	1,053	16								2				0		0
9.....	901	15														
10.....	944	15														
11.....	815	13														
12.....	945	15½														
13.....	1,068	15½														
14.....	1,039	16								1				0		0
15.....	1,012	11														
16.....	1,141	14														
17.....	997	12½														
18.....	962	10½														
19.....	867	11														
20.....	1,038	10														
21.....	1,140	10								0				0		0
22.....	930	10														
23.....	1,003	12														
24.....	1,038	11														
25.....	950	10														
26.....	1,112	13½														
27.....	1,048	14														
28.....	1,063	11½														
29.....	954	12														
30.....	986	12														
31.....	1,027	11														
Total.....	30,025	1403									3			0/3		0/3
Average.....	968										1					
Maximum.....	1,140										2					
Minimum.....	535										0					

¹ 1.6 p. p. m.

OHIO LAW FOR ENFORCING CORRECTION OF STREAM POLLUTION AND IMPROVEMENT OF PUBLIC WATER SUPPLIES.

In 1908 the General Assembly of Ohio enacted a law commonly known as the Bense Act and codified as sections 1249 to 1261, inclusive, General Code of Ohio. This law was passed for the purpose of providing for correction of pollution of streams by sewage and other wastes from municipalities, institutions, industrial establishments, and other sources, and for the improvement of impure and unsafe public